

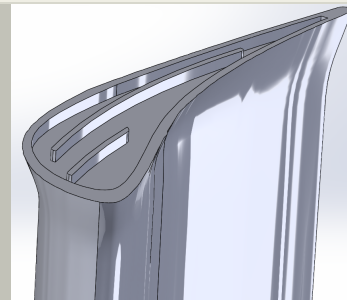
# Improved Efficiency of Small Core Turbines through Tip Leakage and Secondary Flow Mitigation, Phase I

Completed Technology Project (2016 - 2016)



## Project Introduction

NASA's Aeronautics Research Mission Directorate has declared ultra-efficient commercial air vehicles a strategic area for development in the coming decade. With no foreseeable alternatives, advanced gas turbine propulsion will continue to power future subsonic transport aircraft. As a result, engine manufacturers are devoting significant effort to increasing fuel efficiency and pushing engines toward higher fan bypass ratios (BPRs). With fan speed already limiting allowable fan sizes, higher BPR requires new, smaller engine cores. However, component efficiency tends to decrease with decreasing size due in part to enhanced tip leakage and secondary flows. Many of the existing technologies designed to mitigate losses associated with these flow structures have only been investigated in conventional machines, under steady approximations, and/or in single components or stages. Also, they often address only a particular loss mechanism in a given flow structure. The proposed SBIR project innovates on existing mitigation strategies from a practical, holistic perspective to generate novel aerodynamic devices tailored to improve the efficiency of multi-stage, small-core turbines while also accounting for their inherently unsteady nature. The proposed devices, including tip leakage control and endwall treatments for secondary flow control, will be designed by accounting for each loss mechanism in the targeted flow structure and the device's influence on the unsteady flow field in the current stage and upstream and downstream stages. Successful designs will ensure increases in component efficiency also increase engine overall efficiency by avoiding offsetting reduction in loss in one stage with increased loss in another. In Phase I, numerical simulations will be used to devise and characterize feasible loss mitigation technologies. This foundational work will provide justification for comprehensive analysis and experimental evaluation of the most promising concepts in Phase II.



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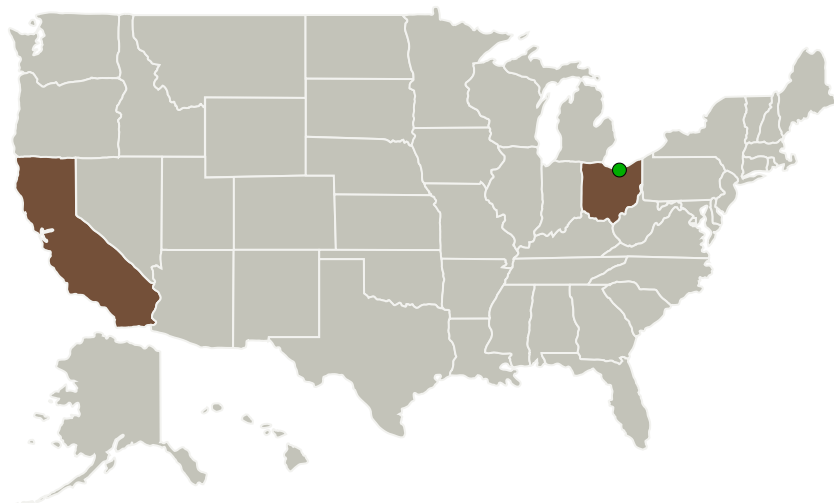
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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
ATA Engineering, Inc.	Lead Organization	Industry	San Diego, California
● Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

## Primary U.S. Work Locations

California	Ohio
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## Project Transitions

▶ **June 2016:** Project Start

✓ **December 2016:** Closed out

## Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/139701>)

## Organizational Responsibility

## Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

## Lead Organization:

ATA Engineering, Inc.

## Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

## Program Director:

Jason L Kessler

## Program Manager:

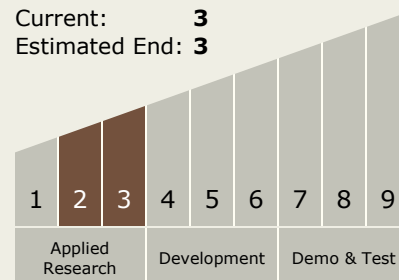
Carlos Torrez

## Principal Investigator:

Timothy Palmer

## Technology Maturity (TRL)

Start: 2  
Current: 3  
Estimated End: 3

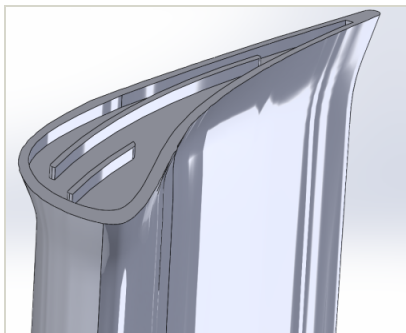


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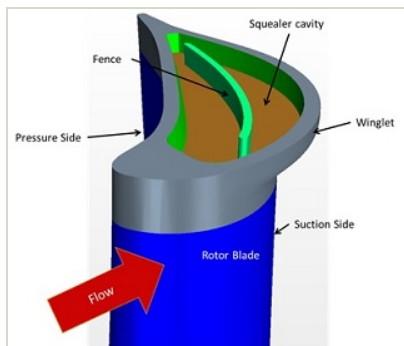


## Images



### Briefing Chart Image

Improved Efficiency of Small Core Turbines through Tip Leakage and Secondary Flow Mitigation, Phase I  
(<https://techport.nasa.gov/image/135831>)



### Final Summary Chart Image

Improved Efficiency of Small Core Turbines through Tip Leakage and Secondary Flow Mitigation, Phase I  
Project Image  
(<https://techport.nasa.gov/image/128126>)

## Technology Areas

### Primary:

- TX15 Flight Vehicle Systems
  - └ TX15.1 Aerosciences
    - └ TX15.1.1 Aerodynamics

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System